How does inclusive innovation play a role in sustainable economic growth?

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Abstract

Inclusive innovation has gained paramount attention in the Industry 4.0 context of the social inclusion of societies in technological product development, which is crucial for sustainable economic growth. This study evaluates the heterogeneous role of inclusive innovation in sustainable economic growth convergence across 70 countries of the developing world from 2000–2019. The panel quantile regression technique was used, which is helpful in the evaluation of absolute and conditional β-convergence on different quantile levels. Additionally, the physical capital saving behaviour per capita worker to achieve conditional convergence in a specified set of developing countries was used. The different values of the β-convergences of adjusted net savings per capita across low income with lower-middle-income countries were also compared. According to conditional convergence results, both sets of countries have the greater absolute, as well as conditional convergence power, toward equilibrium. The policy implications of this study are crucial for the field of technological development and innovation effectiveness. Developing countries should implement inclusive innovation techniques and adjustments to improve the industrial technology crucial for their sustainable development.

Keywords: Inclusive Innovation, adjusted net savings per capita, per worker output, physical savings absolute, conditional β-convergences.

1. Introduction

Innovation is important for sustainable development. Innovative production processes are crucial for the sake of new products, higher living standards, and sustainable economic goals (SDGs). In the Industry 4.0 era, developed countries' expenditures on sustainable production and consumption technologies are high regarding connectivity and business development. This innovative transformation in various economies can improve products that contribute to environmental efficiency, which remains a major concern in the recent sustainable development targets (Cordova & Celone, 2019; Imaz & Eizagirre, 2020). However, the process of creating innovative products is slow in developing countries (Andreoni, Chang, & Labrunie, 2021; Halog & Anieke, 2021). A major driving factor of developed countries is to be more developed than other countries. Considering the relevance of innovation in new sustainable product design, it is crucial to evaluate its significance for sustainable development. However, the financial and economic crisis brought on by the COVID-19 pandemic has made sustainable economic growth objectives difficult to achieve (Barbier & Burgess, 2020; Shulla et al., 2021). In this context, sustainable technological development is necessary to stop the damaging of economies from a socioeconomic perspective (Mortazavi et al., 2021; Schillo et al., 2017). The inclusive innovation adaptation phenomena have the potential to address the socioeconomic exclusion issues affecting sustainable production and development. Therefore, it is necessary and timely to consider the context of inclusive paradigm innovation. Before considering simple innovation, the innovation product process was unsustainable and had a weak effect on society when considering its long-term sustainable path (Abbasi et al., 2022; Greer, von Wirth, & Loorbach, 2021). There is a need to focus on inclusive innovation adaptation in the process of sustainable economic growth and development to involve all segments of society (Hoffecker, 2021).

Inclusive innovation includes the development of new goods and services by and for those who are excluded from mainstream economic development, especially those who are living on small incomes (Opola et al., 2021). Conversely, Heeks et al. (2014) have suggested that inclusive innovation includes people in the mainstream society. These different views have been mentioned in the 'ladder of inclusive innovation'. Therefore, inclusive innovation adaptation is considered an important element to cope with the socio-economic issues in different parts of the world (Patnaik and Bhowmick, 2020). Various factors affect inclusive innovation adaptation and economic growth by way of physical, labour, and human capital through the innovation system.

Furthermore, sustainable economic convergence is vital to test the global sustainable economic growth pattern, and innovation plays a key role in the process of sustainable economic growth. Innovation further reduces income inequalities, which traditionally benefit the rich more than the poor. In recent scenarios, inclusive innovations have become important determinants of balanced sustainable growth (Skare & Porada-Rochon, 2022). Human capital is also a vital element needed for inclusive innovation to occur through formal education (Mortazavi et al., 2020). Therefore, inclusive innovation adaptation regards bringing excluded groups into mainstream economic development and as it is imperative to improve environmental standards, the governments of developing countries should focus on inclusive innovation strategies in production and consumption technology development for a sustainable future.

Regarding the dynamic role of inclusive innovation in sustainable development, this study explores the heterogeneous impact of inclusive innovation on sustainable economic convergence in developing countries in a disaggregated manner. A large segment of product innovation affects the lower segment of societies located at the bottom of the 'pyramid population'. These innovations also affect the overall economic growth of a country and are named inclusive innovation adaptation. Initially, these innovations are ignored in many studies as a large proportion of the global population living below the poverty line were neglected. Inclusive innovation adaptation's effect on sustainable economic growth and the lives of this population has been neglected in past studies. However, researchers are now focusing on inclusive innovation adaptation from a theoretical perspective (Patnaik and Bhowmick, 2020). Based on the conceptual importance of the new inclusive innovation concept, this study is the first to focus on inclusive innovation index development for large-scale developing countries based on McKinley's (2010) methodology. Furthermore, we empirically test its importance in the context of sustainable economic growth convergence.

This study adds to the sustainability and development literature in the following ways: First, this study captures inclusive innovation values empirically after considering the following major paradigms; education role, employment growth, financing SMEs and ICT, and reducing inequality (Gini index). Second, we develop a new empirical design based on the conditional convergence approach to analyse the determinants of sustainable economic growth, augmented using the panel quantile regression method to investigate the convergence and factors that influence long-term economic growth. Finally, we evaluate the degree of convergence across

low- and low-middle-income countries since these two regions differ in technology and product innovation.

This paper is structured as follows: Section 2 provides a review of the literature; Section 3 outlines the materials and methods used in this study; in Section 4, the results are discussed; and Section 5 provides the conclusions of the study and relevant policy implications.

2. Literature Review

2.1 Theoretical Perspective

There are few studies available that have discussed the theoretical aspects of inclusive innovation. Most studies have discussed inclusive innovation's effect on economic growth. Furthermore, few studies have explored inclusive innovation[1] adaptation on economic convergence[2]. Pansera & Owen (2018) have studied inclusive innovation in the process of economic development in India and concluded that inclusive innovation directly impacts economic development. However, it is argued that further critical research is needed to confirm the potential and discourse of this development. Sarkar & Pansera (2017) have discussed inclusive innovation in the context of Mother Earth innovation used for market engagement; this is the idea given by the Grameen Bank that popularized the creation of the women's self-help groups and setting up small businesses in rural Bangladesh with the help of microcredit loans. Furthermore, Schindler et al. (2017) have described innovation as an important driver of economic growth. However, innovation is also described as the main contributor to the increase of socio-economic inequalities. As a result of this drawback, the inclusive innovation concept has been developed by providing frameworks and action guidelines to reduce and measure the increasing inequality effects that innovations create. Inclusive innovations have the potential to become socially responsible and address socio-economic exclusion.

Carayannis et al. (2012) have discussed the concept of inclusive innovations developed to provide the framework and action guidelines for measuring and reducing inequality. Recently in

[1] An inclusive innovation is one in which new products and services are produced for and/or developed by individuals who have been excluded from the development mainstream, notably those who earn the least. Inclusive Innovation enables equal access to products and services by utilising new technology, ideas, persons, and innovations to address new challenges and higher living standards.

[2] When nations with lower levels of GDP per capita reach parity to those with greater levels of GDP per capita, the process is termed convergence. Convergence can occur even when both high- and low-income nations increase investment in physical and human resources with the purpose of expanding GDP.

developing countries, attention has turned to the role of innovations in increasing inequalities. This argument builds on the quadruple helix theory, which has integrated innovations into a social context and considers the government, industry, academia, and civil society as key actors in promoting a democratic approach to innovations. Heeks, Foster & Nugroho (2014) selected targeted groups that included the youth, people with disabilities, women, and ethnic minorities for the intervention of inclusive innovation and investigated entrepreneurs' effects on the informal sector. They argued that inclusive innovation positively impacts the targeted groups. Moreover, Chataway et al. (2014) have explained inclusiveness as a result of innovation and posited that innovations lead to economic outcomes as well as social and environmental outcomes. The most recognized definition of inclusive innovations refers to the context of economic development, specifically to poverty alleviation and considerations of the bottom of the pyramid.

In addition, Paunov (2013) has confirmed the positive effect of formal R&D-based innovation, as well as practice, business, and social innovations. One of the drivers of this argument is that inclusive innovation reflects the social well-being of a marginalized population. Questions of what and who is needed to make innovation more inclusive, as well as why and how these innovations can be more inclusive should be answered. Different groups of people should be involved and different types of innovative activities should be included for the benefits of inclusive innovation to be captured. Furthermore, a broad range of outcomes considering the governance and mechanism of innovation should be investigated. Kallerud et al. (2013) have stated that the expectations regarding innovation are immensely broad and policy developers and citizens expect innovation to contribute toward the solutions of specific societal challenges and issues. Von Schomberg (2012) has identified Responsible Research and Innovation (RRI) as a transparent and interactive process by which societal actors and innovators become responsive to each other to meet society's expectations. It also ensures the sustainability of the innovation process, therefore allowing the proper embedding of scientific advances and technology in society. Similarly, Satorra & Paunov (2017) have illustrated that innovation policies are central to the growth agendas of countries, however, these policies featured less prominently when forming strategies for the promotion of social inclusion.

In conclusion, an increasing number of countries have implemented inclusive innovation policies that aim to boost the capacities and opportunities of disadvantaged individuals;

furthermore, these policies aim to engage in innovation activities, including research and entrepreneurship.

2.2 Empirical Perspective

Scarce studies have been interested in inclusive innovation and economic growth. For instance, Chataway, Hanlin & Kaplinsky (2014) have studied inclusive innovation in the context of economic and policy development. They utilized the panel data set of China and South Asia for the period 1990–2008 and concluded that despite the rapid growth of output, the numbers of people living in absolute poverty have remained high. Furthermore, inclusive innovation plays a primary role in the reorientation of economic growth developmentally and satisfactorily. The government's role of directing available resources to the promotion of inclusive innovation is crucial. Further, Andersen & Andersen (2017) studied innovation for inclusive development and considered the cross-sectional data of different provinces of Indonesia. They argued that the decentralization of innovation programs positively impacted development and its benefits were well distributed to all provinces in Indonesia. Planes-Satorra & Paunov (2017) also examined the role of inclusive innovation policies by considering the cross-sectional data of 15 OECD member countries for the period of 2010–2012. The main conclusion of their study is that innovation policies play a central role in countries' growth agendas but were less considered in the strategies of promoting social inclusion. In a similar context, Schindler, Fisher & Shonkoff (2017) have posited that innovation is the most important driver of economic growth and a contributor to social and economic inequalities. In response to this, the concept of inclusive innovation has been developed to provide a framework and action guidelines to reduce and measure the effects of innovation on inequality.

The available literature has been reviewed in the context of inclusive innovation adaptation and economic growth. The empirical literature is available, however, literature regarding innovation and sustainable economic growth is still missing. Nevertheless, theoretical literature is found in the context of inclusive innovation adaptation. In conclusion, it can be argued that inclusive innovation adaptation in the context of sustainable development perspective is missing from economic literature despite this being a crucial aspect of the process of sustainable production and sustainable consumption in developing economies.

3. Materials and Methods

3.1. Data

This study utilizes data from the Penn-World table and World Bank Development Indicators (WDI). Inclusive innovations indicators data is also gathered from the WDI. Data regarding the variables of real GDP, employment, and gross savings were taken from the Penn-World tables of 2019. The data from 70 countries (see Appendix-1) for the period of 2000–2019 is used. The sources of the data and the variables' definitions are shown in Table 1. This study primarily focuses on sustainable economic growth convergence and inclusive innovation in developing countries. Therefore, we consider adjusted net savings per capita convergence. Our data set is unbalanced to some extent as it is missing values for a few countries.

For inclusive innovation, an index was developed following the methodology of McKinley (2010). First, we chose the indicators and their dimensions, then set the target weights. Here equal weights are assigned to each indicator to perform uniform analysis because each country has different strengths in different indicators (Jha et al., 2018). Inclusive innovation includes the following measurements: education, measured by gross primary school enrolment; reduced inequality, measured by the reciprocal GINI index; ICT usage, measured by mobile cellular subscriptions; and SME financing, measured by SME loan accounts as a percentage of non-financial corporation borrowers. Figure 1 shows that in the context of inclusive innovation, there is a declining trend in selected economies.

Table 1. Variables' definitions and data sources

Variable	Abv.	Definition	References	Source
Environmental Quality				
Adjusted net savings per capita	ANS	Adjusted net savings, including particulate emission damage (% of GNI)	Abou-Ali & Abdelfattah (2013)	WDI
Capital formation	LNS	Gross capital formation as a percentage of GDP	Mota & Cunha (2019), Barbier (2017)	Penn-World Tables
Output per worker	LBF	Worker output per capita	Koirala & Pradhan (2020)	Penn-World Tables
Inclusive innovation Index (Inv)				
Employment rate	G	Employment in industry (% of total employment) (modelled ILO estimate)	Mortazavi, Eslami, Hajikhani & Väätänen (2021), Peerally et al. (2019)	WDI
School enrolment, primary (% gross)	EDU	Adjusted net enrolment rate, primary (% of primary school-age children)	Mortazavi, Eslami, Hajikhani & Väätänen (2021), Villa et al. (2021)	WDI

Gini index	Gini Index	The extent to which the distribution of income (or, in some cases, consumption expenditure) among individuals or households within an economy deviates from a perfectly equal distribution	Mortazavi, Eslami, Hajikhani & Väätänen (2021), Villa, Valencia & Valencia-Arias (2021)	WDI
ICT Usage	ICT	Measured by mobile cellular subscriptions	Mortazavi, Eslami, Hajikhani & Väätänen (2021)	WDI
SME loan accounts	SME	A % of non-financial corporation borrowers	Mortazavi, Eslami, Hajikhani & Väätänen (2021), Villa, Valencia & Valencia-Arias (2021)	WDI

Note: ANS is Adjusted net savings per capita, LNS is Capital formation, LBF is Output per worker, the Employment rate is denoted with G, School enrolment, primary (% gross) is denoted with EDU, ICT usage with ICT, SME represents small and medium sized enterprises and WDI indicate World Development Indicator database.

Figure 1 displays the constructed inclusive innovation index (INV), build based on six major measures, which include; i) average technology growth rate, ii) gross primary school enrolment, iii) reducing inequality, which is measured by reciprocal of GINI index, iv) ICT usage, which is measured by mobile cellular subscriptions, and (v) SME financing measured by SME loan accounts as a percentage of non-financial corporation borrowers. Here added some sentences on the behaviour of the graphics

Figure 1. Inclusive Innovation Index (IQI)

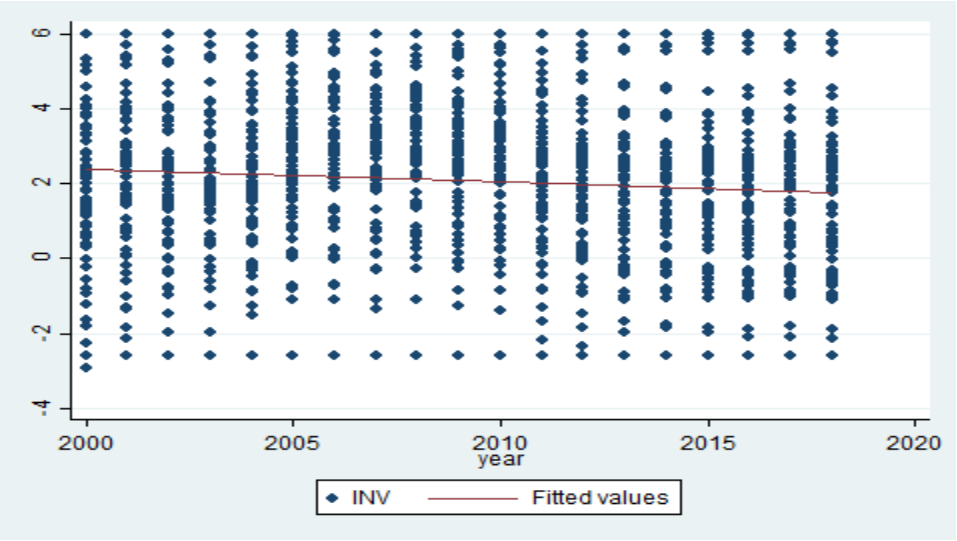


Table 2 outlines the descriptive statistics of all the study variables. The mean value of the adjusted net savings per capita is measured and can be shown to 1.01, with a standard deviation of 0.34. The low mean value indicates that these economies are poor in genuine savings. This is

because, in developing countries, the issue of sustainable resources is often given the lowest priority. The mean value of the inclusive innovation index is 2.07 with a standard deviation of 1.93. This mean value of the index highlights that innovation and technological development are serious concerns that need to be further evaluated in the developing world. The use of inconclusive innovation as a tool for technological development should be taken seriously at the government level of these economies. The mean value of the physical capital formulation, which provides financial support at the individual level for sustainable innovative activities, shows a low value of -1.93 with a standard deviation of 0.07. This low value highlights the dissaving habits of people in these economies. The mean value of the labour involved in sustainable development shows a low value of 0.14 with a standard deviation of 0.083. This low value highlights the low technological productivity of labour in these economies.

Table 2. Descriptive statistics for the full sample

Variable	Obs	Mean	Std. Dev.	Min	Max
INV	1293	2.07	1.935	-2.93	6
LNS	1293	-1.901	.736	-3.4	-.634
LBF	1293	0.147	.083	-.035	.361
LANS	1292	1.001	.034	.725	1.289

Note LANS, log adjusted net savings per capita; INV, inclusive innovation index; LNS, log of gross fixed capital; LBF, log of labour force participation; Std. Dev., standard deviation; Obs denotes the number of observations.

3.2 Model and Method

To estimate the sustainable economic growth convergence, we employed the β-convergence method, which is used to assess the speed of the convergence of developing countries toward more developed ones. Our β-convergence analysis is based on both absolute and conditional values. The absolute β-convergence model shows an initial convergence pattern and has a negative value. This means that variables converge towards steady-state equilibrium. Whereas, a contingent -convergence approach is required to analyse the detrimental influence on growth rates under particular controlled environments (Long et al., 2017). In addition, the scope of current β-convergence models has been extended in the literature regarding their applicability to environmental literature (Christidou et al., 2013; Westerlund and Basher, 2008).

In this study, we test the absolute β-convergence hypothesis, not for economic growth like prior research, but genuine economic savings per capita as this is vital when considering the

environmental qualities of developing countries. The econometric models for the sustainable economic growth convergence are presented in Equation 1:

$$\ln\left(\frac{ANS_{2it}}{ANS_{2it-1}}\right) = \beta_0 + \beta_1 lnANS_{2i(t-1)+\mu_{it}} \ldots\ldots\ldots.(1)$$

Herein, ANS_{2it} in Model (1) denotes adjusted net savings per capita for specific country *i* in year *t*, with μ_{it} then representing the random disturbance. After applying a logarithm to the dependent variables, the yearly rate of growth of the sustainable development indicators at the period *t* is presented. We also developed an econometric model for evaluating the conditional β-convergence of the sustainable development indicators of developing countries, as shown in Equation 2. If the β_0 value is significantly negative, the indicators of sustainable development have conditional β-convergence among the developing nations covered. Whereas, X_{it} represents the set of explanatory variables that include inclusive innovation index, per capita labour output, and capital formation as major determinates of sustainable innovation and development.

$$\ln\left(\frac{ANS_{2it}}{ANS_{2it-1}}\right) = \propto + \beta_0 lnANS + \beta_1 INS_{it} + \beta_2 lnX_{it} + u_{it} \ldots\ldots\ldots.(2)$$

We assumed that our panel data will have some statistical spikes and that at least one of the square approaches would generate biased results. This is due to the issue of heteroskedasticity. There are numerous methods for estimating dynamic panel models that take heteroskedasticity into account. The quantile regression methodology is widely accepted as the most effective way for dividing the conditional distribution of dependent variables into disaggregated quantile groups. Koenker (2004) used the panel quantile method to get better accuracy in their study's parameters. This method is helpful in our model to evaluate the conditional distribution and is the most appropriate approach to adjust for the heterogeneity and outlier issues (Cameron and Trivedi, 2010; Lin et al., 2017).

4. Results and Discussion

Since the variables were distributed in a non-normal way, we could not use the least square method to derive accurate conclusions. Thus, the panel quantile regression methodology is the best technique for evaluating our findings. Before analysing the panel quantile regression model for convergence, we checked the normality of the data by employing the Shapiro-Wilk and Shapiro-Francia tests (see Table-3). We then analysed the distribution values of the full

sample. As a result of the wide range of regional differences, various statistical distributions were established. It is assumed that the Shapiro-Wilk and Shapiro-Francia tests use normal distributions for the null hypothesis. Most of the p-values are less than 10%; therefore, many of the variables are not normally distributed.

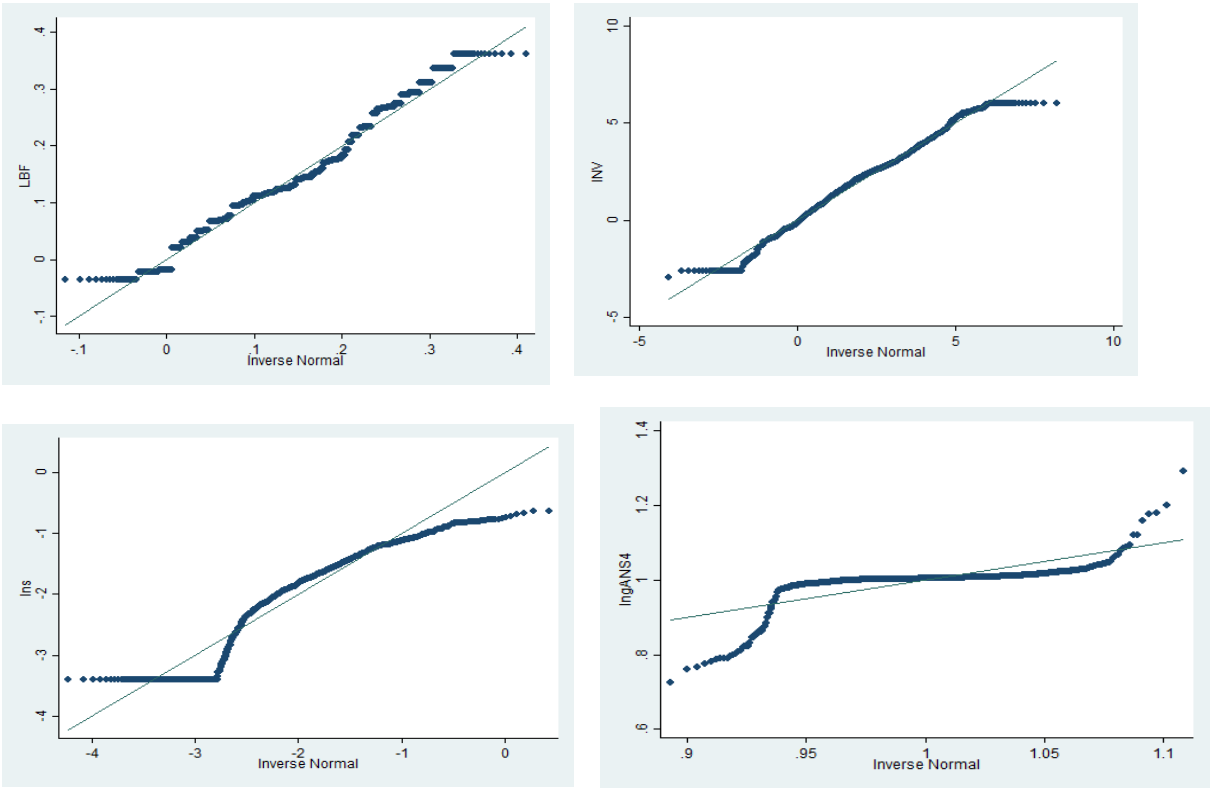
Table 3. Normal diagnostics tests

Variable	**Obs**	**W**	**V**	**z**	**Prob>z**
Shapiro-Wilk W test					
LANS	1,292	0.432	452.526	15.299	0.000
INV	1,293	0.992	6.034	4.497	0.000
LNS	1,293	0.913	69.442	10.610	0.000
LBF	1,293	0.977	18.147	7.252	0.000
Shapiro-Francia W' test					
LANS	1,292	0.429	481.994	14.393	0.000
INV	1,293	0.992	6.631	4.408	0.000
LNS	1,293	0.915	71.562	9.950	0.000
LBF	1,293	0.977	19.133	6.877	0.000

Note: LANS, log adjusted net savings per capita; INV, inclusive innovation index; LNS, log of Gross fixed capital; LBF, log of labour force participation ; $p < .01$, $p < .05$, $p < .1$

To validate the normal distribution test, we drew quantile-quantile (Q-Q) plots. In Figure 2, we show the distributions of the study variables. When the data falls in a straight line, the variables have a normal distribution. This can be confirmed by Shapiro-Wilk and Shapiro-Francia test findings, which demonstrate a non-normal distribution of Q-Q plots of the variables. The quantile regression estimation findings, therefore, have the most effective power to describe the outcomes.

Figure 2. Q-Q Normal Plot



The absolute β-convergence was tested to investigate whether the adjusted net savings per capita converge or diverge in developing countries. Results from panel quantile regression give a more detailed description of the pooled OLS. Among the various quantiles of the distribution, the convergence trend for net savings per capita differs significantly. The results in Table 4 show that the coefficients of the lagged adjusted net savings per capita are significantly negative in the 10th–90th quantiles models. This shows that per capita adjusted net savings in sample countries are converging. The coefficient of the lagged adjusted net savings per capita likewise exhibits a rising trend with the increase in the value of the quantiles. As a result, countries with a high priority on sustainability have higher levels of absolute -convergence. The absolute convergence of per capita income in low and low-middle-income nations is also examined thoroughly. In lower-middle-income countries, the coefficient of the lagged value adjusted net savings per capita are both significant and negative in the Pooled OLS estimation at different quantiles. However, coefficient values show an increasing and decreasing trend at higher quantiles; thus, we can conclude that at higher quantiles the behaviour of low and lower-

middle-income countries are different regarding genuine savings and environment quality (Barbier, 2017).

Table 4. Absolute β-Convergence analysis

	Dependent Variable: The differentiation of Sustainable Development (ANS)									
Full Sample	*OLS*	*10th*	*20th*	*30th*	*40th*	*50th*	*60th*	*70th*	*80th*	*90th*
$ANS_{(t-1)}$	-.003*** (0.000)	-.001*** (0.001)	-.001*** (0.001)	-.0003*** (.000)	-.0038*** (0.005)	-.0006*** (0.0075)	-.0006*** (0.007)	-.0007*** (0.0006)	-.0012*** (.00015)	-.005*** (.00033)
Constant	1.051 (.0083)	1.023 (.009)	1.013 (.0014)	1.007 (.001)	1.009 (.001)	1.01 (.001)	1.01 (.0016)	1.021 (.0018)	1.02 (.0027)	1.043 (.006)
R^2/Pseudo R^2	.028	0.0073	0.0048	0.0043	0.0054	0.0097	0.0148	0.0208	0.0244	0.0284
Lower Middle Income	*OLS*	*10th*	*20th*	*30th*	*40th*	*50th*	*60th*	*70th*	*80th*	*90th*
$ANS_{(t-1)}$	-.002** (.0002)	-.0031*** (0.002)	-.002*** (0.002)	-.0003*** (.0008)	-.008*** (0.005)	-.0009*** (0.007)	-.0006*** (0.007)	-.0004*** (0.00006)	-.002*** (.00045)	-.005*** (.0003)
Constant	1.051 (.0084)	1.023 (.009)	1.013 (.0014)	1.007 (.001)	1.0097 (.001)	1.01383 (.00164)	1.0172 (.0017)	1.0215 (.0019)	1.0288 (.0028)	1.043 (.0067)
R^2/Pseudo R^2	.08	0.007	0.005	0.004	0.005	0.007	0.048	0.0204	0.044	0.084
Low Income	*OLS*	*10th*	*20th*	*30th*	*40th*	*50th*	*60th*	*70th*	*80th*	*90th*
$ANS_{(t-1)}$	-.004*** (.0004)	-.001*** (0.001)	-.002** (0.001)	-.0001*** (.0007)	-.008*** (0.005)	-.0059*** (0.0075)	-.0008*** (0.007)	-.0007*** (0.0006)	-.002*** (.00015)	-.0015*** (.0003)
Constant	1.05 (.0043)	1.03 (.009)	1.03 (.0018)	1.008 (.001)	1.007 (.001)	1.0143 (.00154)	1.0191 (.0079)	1.026 (.0018)	1.028 (.0028)	1.0431 (.0068)
R^2/Pseudo R^2	0.048	0.005	0.006	0.0063	0.005	0.0097	0.015	0.020	0.044	0.028

Note: $ANS_{(t-1)}$ is lag of adjusted net savings per capita, $p < .01$, $p < .05$, $p < .1$

We also examine the conditional β-convergence to assess whether adjusted net savings per capita reaches a stable level after a set of control variables are included. Table 5 reports the conditional β-convergence analysis in the full model. The lagged adjusted net savings per capita have a negative effect on adjusted net savings per capita convergence at the 10th–90th quantiles models, which is consistent with the results of the absolute β-convergence analysis. The coefficient values adjusted net savings per capita convergence model is present in higher quantiles, indicating that these have a comparatively larger convergence value at these levels. The inclusive innovation variable shows a significantly positive effect on per capita adjusted net savings per capita convergence; however, its progress is slower at different quantiles (Foster and Heeks, 2016). This is because the education trend shows that education is improving gradually

but does not fulfil the demand of growing industries in the developing world in the context of technological innovation (Psacharopoulos and Patrinos, 2018). Education provision should be according to the need of the social and modern industry (Weber, 2011). Furthermore, employment is growing slowly due to a mismatch of workers' skills and the demands of industries; fewer employment opportunities are available in the market due to low investments and the poor economic conditions of developing countries. Inequality is reducing at a slower rate and because of poor economic conditions and inflation, this gap is widening. This situation is the same regarding income in lower-middle-income countries and it is clear that improvements in public policy, social welfare programs, and progressive taxation are needed. The use of ICT, such as mobile cellular services and internet services, shows great progress; however, its use for productive purposes, sharing industrial information, the automation of the industry, and knowledge sharing are not satisfactory (Mirza et al., 2020). Public and private industry incentives should be enhanced for ICT's productive use and cost-effectiveness; moreover, ideas sharing will have positive effects on production. Furthermore, ICT impacts the economy significantly and plays a positive role in employment generation. Private and public financial institutions should increase their funding and outreach to small entrepreneurs.

Table 5. Conditional β-Convergence Analysis of Sustainable Development

Dependent Variable: The differentiation of Sustainable Development (ANS)										
Full Sample	*Panel OLS*	*10th*	*20th*	*30th*	*40th*	*50th*	*60th*	*70th*	*80th*	*90th*
$ANS_{(t-1)}$	-.007*** (0.001)	-.004*** (0.001)	-.002*** (0.000)	-.001*** (.00012)	-.001*** (.00095)	-.001*** (.00096)	-.001*** (.00011)	-.001*** (.00012)	-.002*** (.0001)	-.003*** (.0005)
INV	.005*** .(001)	.003*** (.001)	.001*** 0.00	.001*** (.00012)	.001*** (.00009)	.001*** .(.0009)	.001*** (.00010)	.001*** .00012	.001*** (.00017)	.002*** (.0005)
LNS	-.055*** (.012)	-.025*** (.022)	- 0.001** * (0.99)	.001*** (.0028)	.004*** (.00206)	.005*** (.00207)	.007*** (.00224)	.003*** (.00273)	0.002 .(0036)	.003** (.0118)
LBF	.007** (.001)	.006** (.002)	.002 (.002)	.001*** (.002)	.001*** (.0002)	.001*** (.0002)	.001*** (.0002)	.001*** (.0002)	.001*** (.0003)	0.04*** (.001)
Constant	1.141 (.012)	1.073 .(.021)	1.03 (0.003)	1.019 (.0002)	1.018 (.00203)	1.02 (.00204)	1.023 (.0022)	.002684 (.0022)	1.039 (.00022)	1.061 (.011)
R^2/Pseudo R^2	0.1271	0.0355	0.0179	0.0163	0.0210	0.0097	0.0333	0.0388	0.0446	0.048
Lower Middle Income	*Panel OLS*	*10th*	*20th*	*30th*	*40th*	*50th*	*60th*	*70th*	*80th*	*90th*
$ANS_{(t-1)}$	-.006*** (0.001)	-.005*** (0.002)	-.002*** (0.001)	-.001*** (.0001)	-.003*** (.00009 5)	-.001*** (.00061)	-.001*** .(00039)	-.001*** (.0001)	-.003*** (.0001)	-.004*** (.0005)
INV	.004*** .(001)	.002*** (.001)	.002*** (0.001)	.002*** (.0002)	.002*** (.00009)	.001*** .(.0009)	.003*** (.00010)	.001*** (.0002)	.002*** (.0001)	.0021** * (.0005)
LNS	-.035***	-	-0.01***	.003***	.003***	.004***	.006***	.004***	0.001	.002**

	(.01)	.0020*** (.025)	(0.90)	(.0026)	(.002)	(.00307)	(.0020)	(.0028)	.(0030)	(.01)
LBF	.007** (.001)	.006** (.002)	.002 (.002)	.001*** (.002)	.001*** (.0002)	.001*** (.0002)	.001*** (.0002)	.001*** (.0002)	.001*** (.0003)	0.o4*** (.001)
Constant	1.15 (.012)	1.07 .(.022)	1.04 (0.003)	1.02 (.0002)	1.016 (.0021)	1.03 (.0025)	1.020 (.0026)	.0028 (.0020)	1.04 (.0002)	1.054 (.011)
R^2/Pseudo R^2	0.120	0.0355	0.0179	0.0163	0.0210	0.0097	0.0333	0.0388	0.0446	0.048
Low Income	*Panel OLS*	*10th*	*20th*	*30th*	*40th*	*50th*	*60th*	*70th*	*80th*	*90th*
$ANS_{(t-1)}$	-.008*** (0.002)	-.005*** (0.001)	-.002*** (0.001)	-.003*** (.0002)	-.006*** .000095	-.002*** (.00096)	-.001*** .00029	-.003*** (.00012)	-.002*** (.0002)	-.004*** (.0005)
INV	.004*** .(001)	.004*** (.001)	.002*** 0.00	.001*** (.0001)	.002*** (.00009)	.001*** .(.00009)	.001*** (.00010)	.002*** .00012	.001*** (.00017 2)	.001*** (.000)
LNS	-.050*** (.012)	-.05*** (.05)	-0.001*** (0.99)	.003*** (.0027)	.004*** (.0021)	.005*** (.00207)	.007*** (.00224)	.004*** (.00273)	0.002 .(0036)	.003** (.0118)
LBF	.007** (.001)	.006** (.002)	.002 (.001)	.001*** (.002)	.001*** (.0002)	.0017*** (.0002)	.001*** (.0002)	.001*** (.0002)	.001*** (.0003)	0.o4*** (.001)
Constant	1.161 (.012)	1.073 .(.021)	1.03 (0.003)	1.010 (.0002)	1.018 (.00203)	1.02 (.00204)	1.023 (.0022)	.0084 (.04)	1.039 (.00022)	1.071 (.021)
R^2/Pseudo R^2	0.1271	0.0355	0.0179	0.0163	0.0210	0.007	0.043	0.0388	0.046	0.058

Note: $ANS_{(t-1)}$ is lag of adjusted net savings per capita, p < .01, p < .05, p < .1

The estimated coefficient of the natural log of the saving output ratio suggests a negative value in the full and disaggregated samples of low income and lower-middle-income countries. This is because saving habits or investment in the industrialization process in these economies are not supportive of sustainable production and sustainable consumption, which ultimately degrades the economy (Essandoh et al., 2020). The labour force is cooperative and has an intention towards resource savings as seen by the labour force participation in the full and disaggregated samples.

5. Conclusions

The significance of technological innovation in Industry 4.0 is an important subject in sustainable development. In this context, innovation and development of new products, either in form of durable or non-durable, have received tremendous attention from the scientific community. The social scientists are aiming to determine if innovation can be achieved through a participatory approach, which benefits the poor segments of society and has a greater effect on the environment in developing economies. This study is an attempt to quantify inclusive

innovation and highlight its empirical importance for sustainable product development, which may lead the society towards achieving the sustainable development goals.

Based on our study findings we suggest that the process of inclusivity of the information communication, industrial, and education sectors, as well as the marginalized segments in the process of new product development and design, is slow because of the weak structural systems of these economies. This process of inclusivity should be improved via structural changes through active involvement in the process of sustainable technological production design. However, the empirical outcomes pertain to sustainable economic development; therefore, inclusive innovation policies should be the focus despite individual innovation efforts. In this way, the low- and lower-middle-income developing economies can move toward their steady-state convergence patterns in the long term. The pattern and design of industrial innovation should have an inclusive approach, especially in developing economies. Moreover, we observe the major flaw of capital savings or investment aimed toward genuine resource dissaving or deterring environmental resources. The orientation of these economies with sustainable production and sustainable consumption patterns should be considered vital for achieving positive outcomes of sustainability. Furthermore, it was found that human capital involvement informs labour participation, and national productivity signals positive outcomes in the sustainable development paths of a specific set of countries. Therefore, further government attention in human capital is a potential step toward sustainability and environmental protection. This study can be extended by incorporating the proposed index at the global level. Furthermore, future research should be conducted to capture the nexus between a wider range of environmental indicators and inclusive innovation indicators.

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